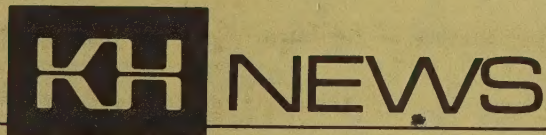


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Model 6620

Operating & Maintenance  
Manual



## MODIFICATION SHEET

Date: January 11, 1989

Model: Krohn-Hite Model 6620 Precision Phasemeter

Ref: Extended accuracy specification

The Model 6620-12 has been tested and is guaranteed to operate at 120kHz, 225mVrms,  $\pm 3\text{dB}$ ; with an accuracy of 0.1%.



1Hz to 10MHz

PROGRAMMABLE PRECISION PHASEMETER

MODEL 6620

Serial No. 351

PRELIMINARY  
OPERATING AND MAINTENANCE MANUAL

KROHN-HITE CORPORATION  
255 Bodwell Street, Avon, MA 02322  
Tel: 617-580-1660 ; TWX: 710-345-0831



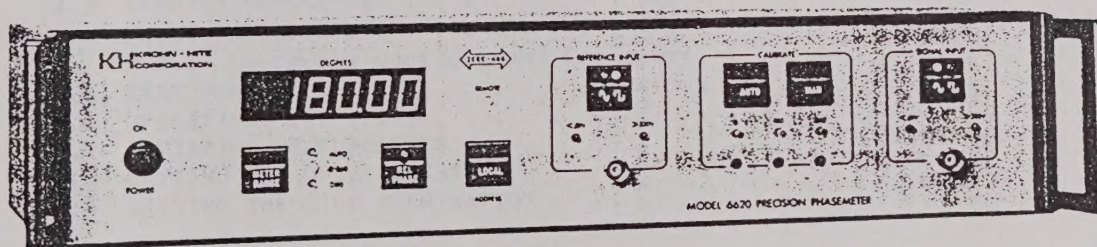
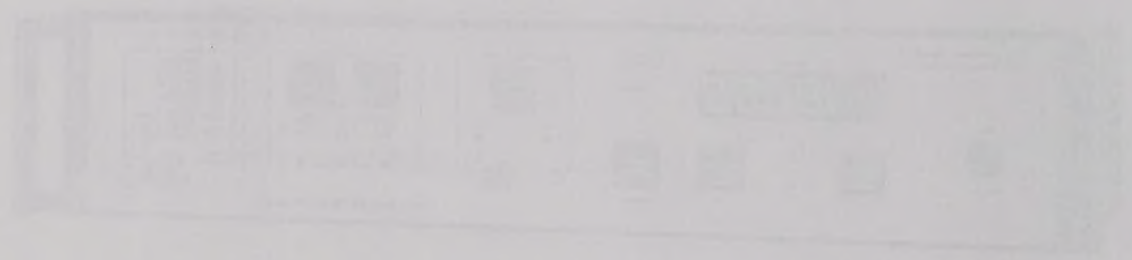


Figure 1. Model 6620



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## SECTION 1

## GENERAL DESCRIPTION

## 1.1 INTRODUCTION

The Krohn-Hite Model 6620 Precision Phasemeter measures the phase angle between two waveforms of coincident frequency, over a range of 10Hz to 10MHz (1Hz Optional), with a typical accuracy of 0.02° and 0.01° resolution. It will accept a wide range of input signal levels from 10 millivolts to 320 volts rms, and input waveforms of sine, square, triangle, and pulses of >50ns. A 5 digit, LED display provides continuous direct readout of phase angles between 0.00° and 360.00°, or  $\pm 180^\circ$ . These two ranges can be selected either manually or automatically.

The 6620 employs a technique that eliminates phase reading errors usually associated with component drift called AUTOMATIC METER CORRECT (AMC). AMC provides instant correction of phase readings for zero and full scale errors, making phase measurements more accurate and reliable.

The 6620 also provides a RELATIVE measurement mode which allows the monitoring of phase deviations, automatic selection of the input voltage range, front panel indicators to indicate a too low/high input voltage range, and an analog output which provides a dc voltage equal to  $-10\text{mv}/^\circ$  for use with an external meter or recorder.

Below are the Options available for the 6620:

- RK-316: Rack Mount Kit for standard 19" rack spacing.
- 002 : 1Hz operation.
- 003 : Rear panel BNC connectors for REFERENCE and SIGNAL inputs.
- 004 : RS232 interface replaces IEEE-488 interface.

The Phasemeter has been carefully inspected, aged, and adjusted before shipment, and is ready for operation when unpacked. If the instrument has been damaged in shipment, make a claim with the carrier and notify Krohn-Hite immediately.

# RESPONSE

Time Constant : >10Hz, less than 500msec; <10Hz, less than 5sec.

Settling Time : To within specified accuracy, within 1 to 8 seconds, dependent on input amplitude and frequency (>10Hz).

# DRIFT

vs. time : (30 days without AMC or CALIBRATE reset) Sine Wave,  $\pm 0.025^\circ$  from 20Hz to 100kHz;  $\pm 0.1^\circ$  at 10Hz;  $\pm 0.1^\circ$  per 100kHz above 100kHz. Square Wave,  $\pm 0.025^\circ$  from 10Hz to 5kHz;  $\pm 0.05^\circ$  to 100kHz;  $\pm 0.1^\circ$  per 100kHz above 100kHz.

vs. temperature : (Without AMC or CALIBRATE reset)  $\pm 0.01^\circ/\text{C}$ , 10Hz to 100kHz;  $\pm 0.05^\circ/\text{C}$  to 1MHz;  $\pm 0.05^\circ/\text{C}$  per MHz above 1MHz.

ANALOG OUTPUT : (for use with an external meter or recorder) 0-3.6 or  $\pm 1.8$  volts DC, 10mV DC/degree phase, impedance 50 ohms.

DISPLAY : 0.5", 7 segment, green LED.

DISPLAY RANGES : Automatic,  $0.00^\circ$  to  $360.00^\circ$  or  $\pm 180.00^\circ$ .

RESOLUTION :  $0.01^\circ$ .

REPEATABILITY : Better than  $.01^\circ$ .

POWER CABLE : 7 feet, removable.

DIMENSIONS :  $3\frac{1}{2}"$  (9cm) high,  $16\frac{1}{2}"$  (41.9cm) wide, 16" (40.6cm) deep.

WEIGHTS : Net weight 15 lbs. (6.75kg), Shipping weight 18 lbs (8.1kg).

AMBIENT TEMPERATURE RANGE :  $0^\circ\text{C}$  to  $50^\circ\text{C}$ .

FRONT PANEL CONTROLS : POWER, METER RANGE, REL PHASE, LOCAL, Reference Waveform, Signal Waveform, CALIBRATE (AMC and MAN).

POWER REQUIREMENTS : 90-132V or 198-264V, single phase, 50-400Hz, 40W.

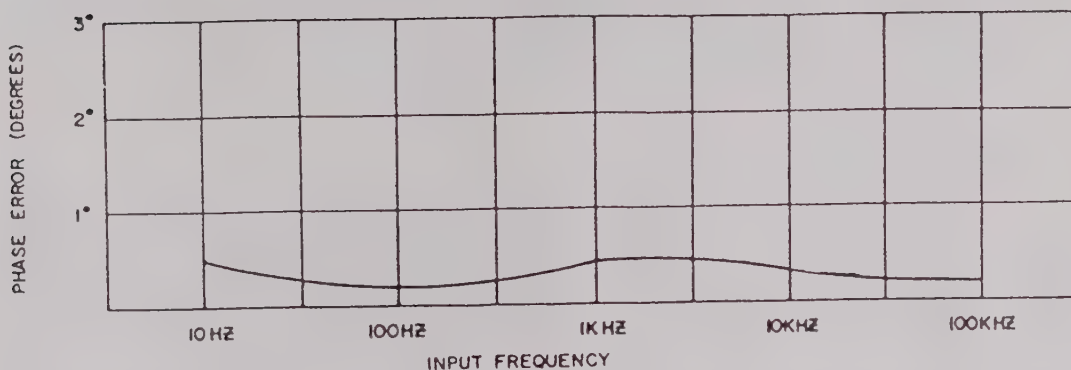


Figure 2. Phase Error vs. Random Noise

### 1.3.3 Distortion Present On The Input Signal

If there is distortion present on one of the input signals, a phase error may be introduced, depending upon the relationship between the fundamental and its harmonics. If the amplitude of all the odd or even harmonics add up to zero at the positive zero crossing of the fundamental, then the harmonics will produce no phase error. If the resultant of the amplitudes is not zero, however, it will cause a shift in the zero crossing of the input waveform. (Worst case would occur when the maximum of the harmonic coincides with the positive zero crossing of the fundamental). The effect of an even harmonic will not only shift the zero crossing of the waveform, but also alter the symmetry of the comparator or detector output. If a symmetry control loop is added to the phasemeter circuit, the effect of the even harmonic on accuracy can be minimized. The 6620 uses the type of symmetry loop mentioned above.

The effect of an odd order harmonic is not as easily corrected. An odd order harmonic simply shifts the phase of the output of the comparator or detector loop. Since the symmetry is not affected, there is no way to detect any phase error.

## SECTION 2

### OPERATION

#### 2.1 INTRODUCTION

This section describes the basic operation of the Model 6620. It includes the proper ac power requirements, the recommended turn-on procedure and a detailed explanation of all operating controls and modes of operation.

#### 2.2 POWER REQUIREMENTS

The 6620 is designed to operate from a single phase, 50-400Hz ac power source of 90-110, 108-132, 180-220 or 216-264 volts. Line switches on the rear panel allow the 2400 to be powered from one of the above 4 voltage ranges. The ac power receptacle, on the rear panel, is a standard 3-pin connector and complies with the European I.E.C. standard. A detachable line cord is provided with the instrument.

The fuse receptacle contains a properly rated fuse for the instrument's point of destination's power requirements.

#### 2.3 TURN-ON PROCEDURE

- a. Set the line switches for the correct voltage range and check to see that a fuse with the correct rating is in the fuse receptacle.

For 90-110 volts, set the 120V/240V switch to 120V and the NORM/LO switch to LO. The fuse should be 3/4 amp.

For 108-132 volts, set the 120V/240V switch to 120V and the NORM/LO switch to NORM. The fuse should be 3/4 amp.

For 180-220 volts, set the 120V/240V switch to 240V and the NORM/LO switch to LO. The fuse should be 3/8 amp.

For 216-264 volts, set the 120V/240V switch to 240V and the NORM/LO switch to NORM. The fuse should be 3/8 amp.

- b. Make sure that the POWER switch is in the OFF position.
- c. Plug the line cord into the unit and into an ac outlet.

#### WARNING!

The chassis of this instrument is connected to ground. For safety purposes, connect the line cord to a grounded, 3 terminal ac outlet.

address. Once the menu is displayed, pressing [METER RANGE] will increase the address number and pressing [REL PHASE] will decrease the address number.

After the address is set, pressing [LOCAL] again will display another menu for setting the line termination. Pressing [METER RANGE] and [REL PHASE] will select the desired line termination configuration.

Pressing [LOCAL] again will return the display to normal operation.

6. WAVEFORM SELECT : Selects the desired waveform that will be applied to the unit.
7. AUTO : Selects the Auto Meter Correct (AMC). When pressed, the unit will cycle through and calibrate the meter at 0°, 180°, and then 360°. This feature will not calibrate the analog output of the unit, only the meter.
8. MAN : When pressed, an LED indicator over one of the screw-driver adjustments on the front panel will light, indicating the adjustment to be made. When the last adjustment has been made, pressing the [MAN] key will return the display back to normal operation.
9. WAVEFORM SELECT : Selects the desired waveform that will be applied to the unit.
10. REFERENCE INPUT : BNC, 10mV to 320V rms.
11. SIGNAL INPUT : BNC, 10mV to 320V rms.

## 2.5 REAR PANEL

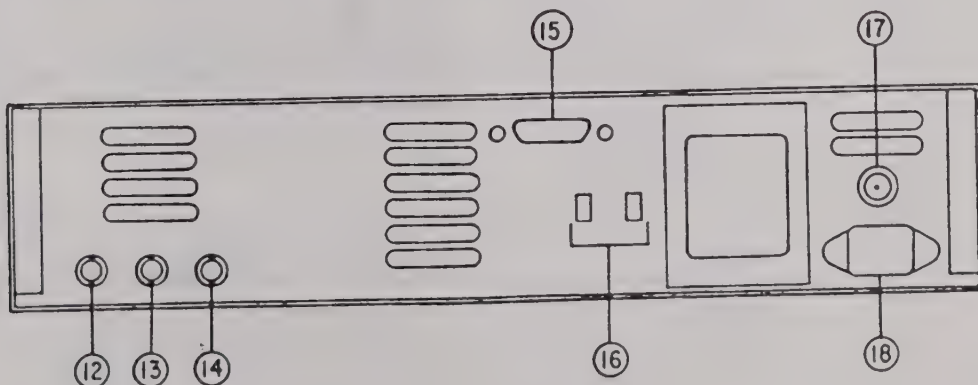


Figure 5. Rear Panel

Once the input cables are connected to the proper input BNC's, press the WAVEFORM keys on each channel to select the desired input waveform being input to each channel. If the [sine] is selected, the phasemeter will measure phase angles between sine waves, a sine and triangle wave, or triangle waves. If the [square] is selected, the phasemeter will measure squarewaves, a squarewave and a pulse that is  $>50\text{ns}$ , or pulses  $>50\text{ns}$ . It is recommended, however, that when a [sine] is selected with a [square], that the sine wave, which will be the cleanest signal, be placed on the REFERENCE INPUT. If a sinewave is used when [square] is selected, an error of several degrees can be expected.

After selecting the proper WAVEFORM, check to see that the LEDs above the input BNCs of both the REFERENCE and SIGNAL inputs are not lit. When the input voltage is less than  $10\text{mV rms}$  ( $<.01\text{V}$ ) or greater than  $320\text{V rms}$  ( $>320\text{V}$ ), the appropriate LED will light to indicate the too low/high condition. If either of the LEDs are lit, adjust the input voltage level until the LED turns off.

When the input voltages are adjusted to within the limits of the phasemeter, the METER RANGE must be selected. The METER RANGE has three selections to choose from; AUTO, 0-360, and  $\pm 180$ .

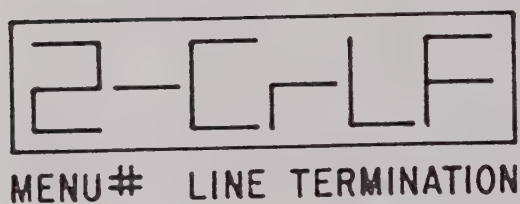
1. AUTO : When this range is selected, the phasemeter will switch ranges automatically between 0-360 or  $\pm 180$ . If the AUTO METER RANGE is on the 0-360 range, and the phase angle being measured is approaching  $10.00^\circ$  or  $350.00^\circ$ , the phasemeter will automatically switch to the  $\pm 180$  range. The same results will occur when the AUTO METER RANGE is on the  $\pm 180$  range. When the phase angle being measured approaches  $+170.00^\circ$  or  $-170.00^\circ$ , the phasemeter will automatically switch to the 0-360 range. This feature allows the user to continuously measure phase angles without interruption.
2. 0-360 : This range, when selected, will measure phase angles between  $-5.00^\circ$  and  $365.00^\circ$ . For phase angle measurements passing through  $360.00^\circ$ , the display will remain at the  $360.00^\circ$  end until the reading is approximately  $365.00^\circ$ . At this point, the phasemeter will switch to the  $0.00^\circ$  end, and to its corresponding point of approximately  $5.00^\circ$ .

Conversely, if the phase angle being measured is passing through  $0.00^\circ$ , the display will remain at the  $0.00^\circ$  end until the reading is approximately  $-5.00^\circ$ , where the phasemeter will switch to the  $360.00^\circ$  end, to a new display of approximately  $355.00^\circ$ .

3.  $\pm 180$  : This range operates in the same manner as the 0-360 range, and will measure phase angles between  $-185.00^\circ$  and  $+185.00^\circ$ . For phase angle measurements passing through  $+180.00^\circ$ , the display will remain at the  $+180.00^\circ$  end until the reading is approximately  $+185.00^\circ$ . At this point, the phasemeter will switch to the  $-180.00^\circ$  end, to its corresponding point of approximately  $-175.00^\circ$ .

## 2.9 SETTING THE LINE TERMINATION

After the GPIB Address is set, pressing the [LOCAL] key momentarily again will display menu 2 for setting the line termination. Once again, pressing the [METER RANGE] key and/or the [REL PHASE] key will select the desired line termination configuration (refer to Figure 7 below).



| <u>Choices</u> |                           |
|----------------|---------------------------|
| Cr             | Carriage Return           |
| LF             | Line Feed                 |
| CrLF           | Carriage Return/Line Feed |
| LFCr           | Line Feed/Carriage Return |
| NONE           | No Termination            |

Figure 7. Line Termination Menu

## SECTION 3

## GPIB PROGRAMMING

## 3.1 INTRODUCTION

The Krohn-Hite Model 6620 is completely compatible with the IEEE-488 Standard (GPIB) Interface Bus. All data can be read and all front panel controls can be set via the bus.

## 3.2 IMPLEMENTATION SUB SET

Identification and capabilities:

SH1 : Complete source handshake.  
AH1 : Complete acceptor handshake.  
T5 : Basic talker, with talk-only mode, talker is un-addressed when unit is addressed to listen.  
L4 : Basic listener, no listen-only mode, listener is un-listened when unit is addressed to talk.  
SR1 : Service requested when any out of range condition occurs.  
RL1 : Complete Remote/Local and Local lockout control.  
PP1 : Complete parallel poll capabilities.  
DC1 : Complete device clear capabilities.  
DT0 : No device trigger.  
CO : No controller capability.  
E1 : Open collector drivers.

## 3.3 IEEE-488 BUS DATA TRANSFERS

To receive commands, the 6620 must first receive its primary listen address. This is followed by the desired command. The commands are executed immediately upon receipt. This means no termination character or EOI message is needed, however, these may be sent if desired.

The following chart indicates the ASCII characters that must be received to operate the various controls.

| <u>ASCII CODE</u> | <u>CONTROL FUNCTION</u>    |
|-------------------|----------------------------|
| M1                | Auto Range Mode            |
| M2                | 360° Range Mode (non-auto) |
| M3                | 180° Range Mode (non-auto) |
| P0                | Non-Relative Phase Mode    |
| P1                | Relative Phase Mode        |

## 4 - REFERENCE CHANNEL ERROR INDICATORS

- 0 = reference channel within range ( No Error)
- 1 = reference channel under range
- 2 = reference channel overload error

## 5 - PHASEMETER RANGE INDICATORS

- 1 = manual range mode/360° range
- 2 = manual range mode/180° range
- 3 = auto range mode/360° range
- 4 = auto range mode/360° range

## 6 - RELATIVE PHASE MODE INDICATOR

- 0 = absolute phase mode
- 1 = relative phase mode

## 7 - CALIBRATION INDICATORS

- 0 = no calibration LEDs lit
- 1 = 0° calibration LEDs lit
- 2 = 180° calibration LED lit
- 3 = 360° calibration LED lit

## DEVICE CLEAR

Since the manual keyboard is capable of leaving the 6620 in either the SET GPIB ADDRESS/LINE TERMINATION MODE or a CALIBRATION MODE, the DEVICE CLEAR instruction (DCL) should be employed at the start of a GPIB sequence. DCL will put the instrument into AUTO RANGE/0-360 RANGE, NON-RELATIVE PHASE ANGLE MODE, SIGNAL/REFERENCE CHANNEL SINEWAVE MODE, as well as resetting instrument to PHASE ANGLE DISPLAY and NON-CALIBRATION MODE.

## 3.4 IEEE-488 STANDARD COMMANDS

These commands are sent with ATN true as described in the Standard.

## 3.4.1 Multi-line Messages

| <u>IEEE-488 COMMAND</u> | <u>MNEMONIC</u> | <u>RESULT</u>                                                                                                    |
|-------------------------|-----------------|------------------------------------------------------------------------------------------------------------------|
| My Listen Address       | MLA             | Enables unit to receive data.                                                                                    |
| Unlisten                | UNL             | Disables all units from receiving data.                                                                          |
| My Talk Address         | MTA             | Designates unit to send data.                                                                                    |
| Untalk UNT              | Disables all    | Disables all units from sending data.                                                                            |
| Local lockout           | LLO             | Disables return to local key on front panel such that only the controller can activate the front panel keyboard. |

| <u>IEEE-488 COMMAND</u> | <u>MNEMONIC</u> | <u>RESULT</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Configure               | PPC             | Places unit into a state where it expects parallel poll enable and disable commands to establish which bits should be set or selected in response to a parallel poll.                                                                                                                                                                                                                                                                                                                               |
| Unconfigure             | PPU             | Removes unit from PPC state (UNL does the same thing but also unlistens device).                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Enable                  | PPE             | When unit is in PPC state, it indicates which bit and which polarity the device should respond. Hex codes 60-67 selects bits 0-7 respectively to be set to 0 for a true error response. Since logic 0 is HI on open collector lines, this provides a logical "OR" of all units designated to respond with given line. Hex codes 68-6F selects bits 0-7 respectively to be set to 1 for a true (error) response. This can provide logical NAND of all units designated to respond with a given line. |
| Disable                 | PPD             | Clears any configuration previously entered. This is valid only when unit is in PPC state.                                                                                                                                                                                                                                                                                                                                                                                                          |

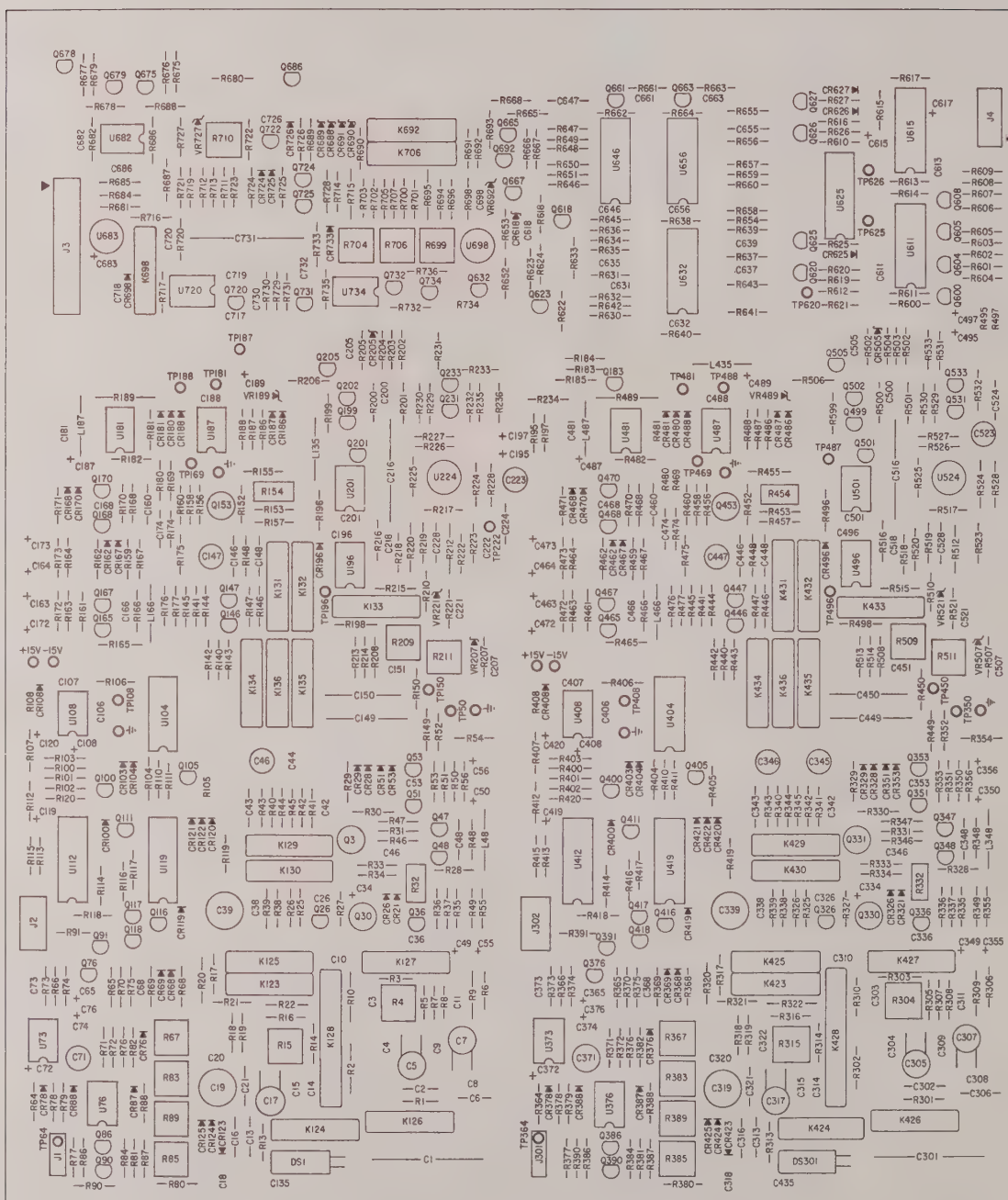
#### SERVICE REQUEST AND SERIAL POLLING

The Model 6620 has complete serial poll capabilities. When a serial poll is conducted, a "BYTE" of data is sent. Bits 0-3 indicate the type of error.

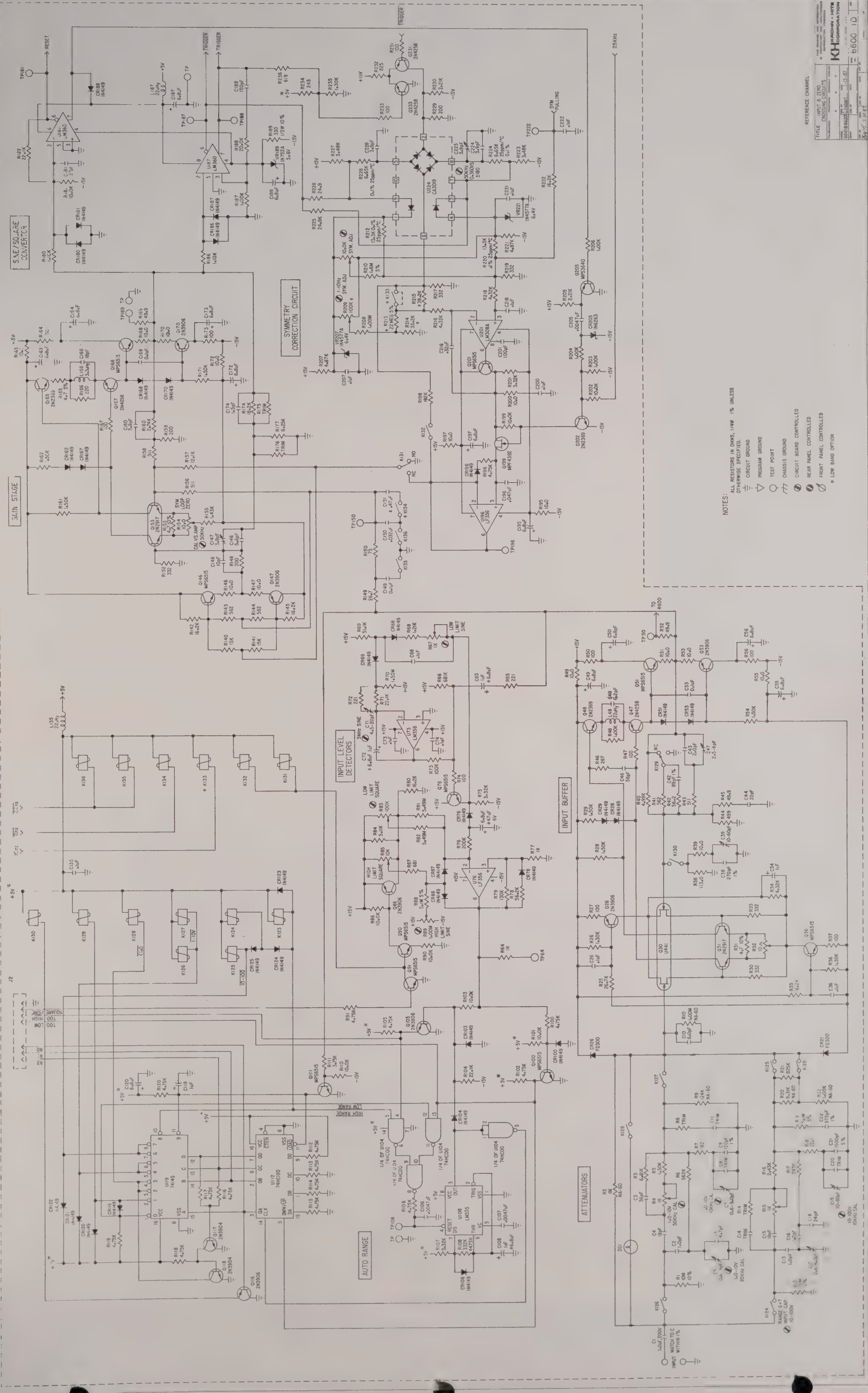
The following chart indicates the error types:

| <u>B7 - B0</u> | <u>HEX</u> | <u>ERROR TYPE</u>                     |
|----------------|------------|---------------------------------------|
| 0000 0000      | 00         | No error                              |
| 0000 0001      | 01         | Signal Channel under range (<.01V)    |
| 0000 0010      | 02         | Signal Channel over range (>320V)     |
| 0000 0100      | 04         | Reference Channel under range (<.01V) |
| 0000 1000      | 08         | Reference Channel over range (>320V)  |





MODEL 6600 SERIES PC6600-I

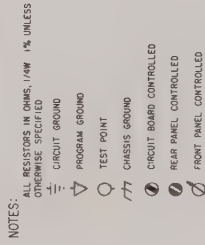


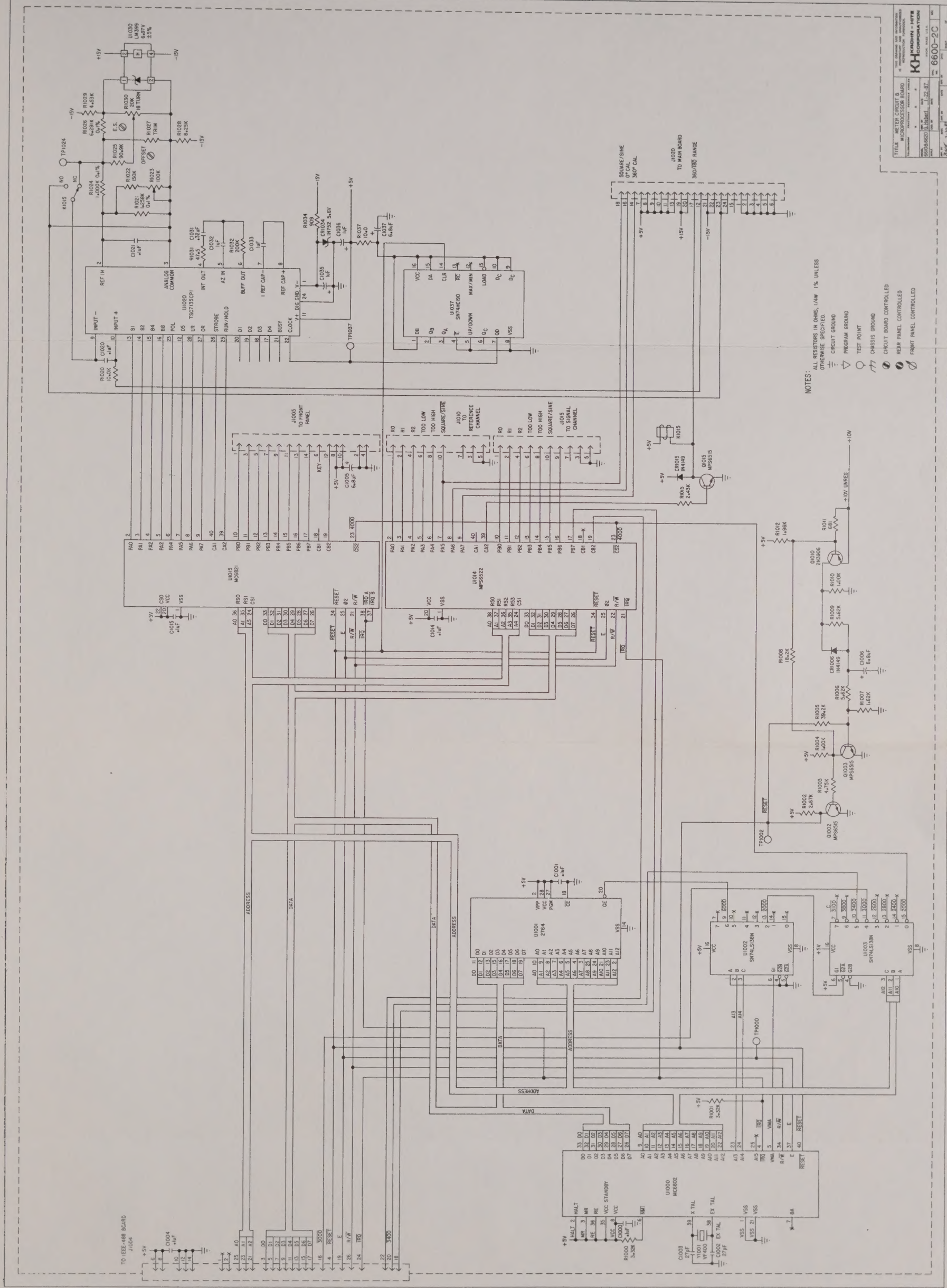
NOTES:  
ALL RESISTORS IN OHMS, 1/4W 1% UNLESS OTHERWISE SPECIFIED.  
CIRCUIT GROUND  
PROGRAM GROUND  
TEST POINT  
CHASSIS GROUND  
CIRCUIT BOARD CONTROLLED  
REAR PANEL CONTROLLED  
FRONT PANEL CONTROLLED  
\* LOW BAND OPTION



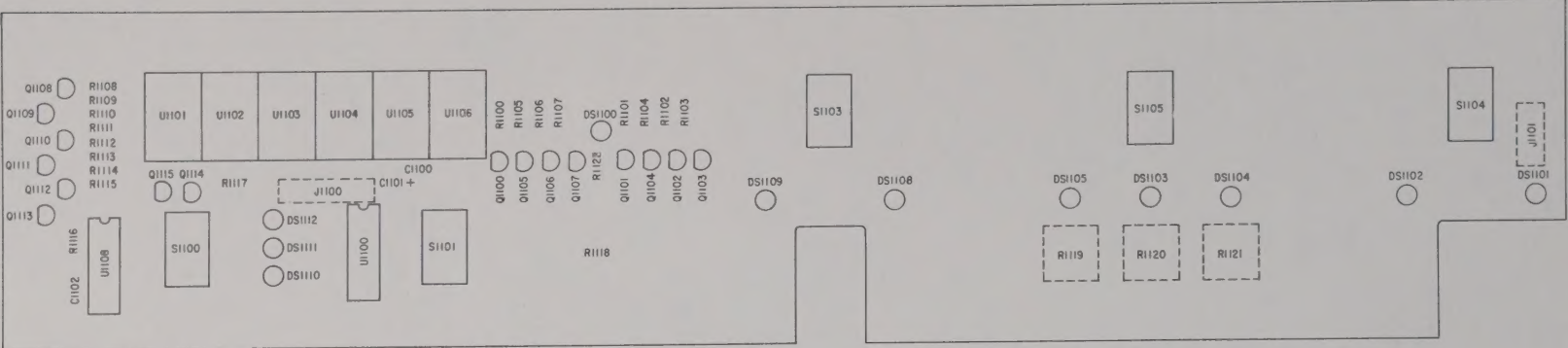
MODEL 6600 SERIES PC6600-I



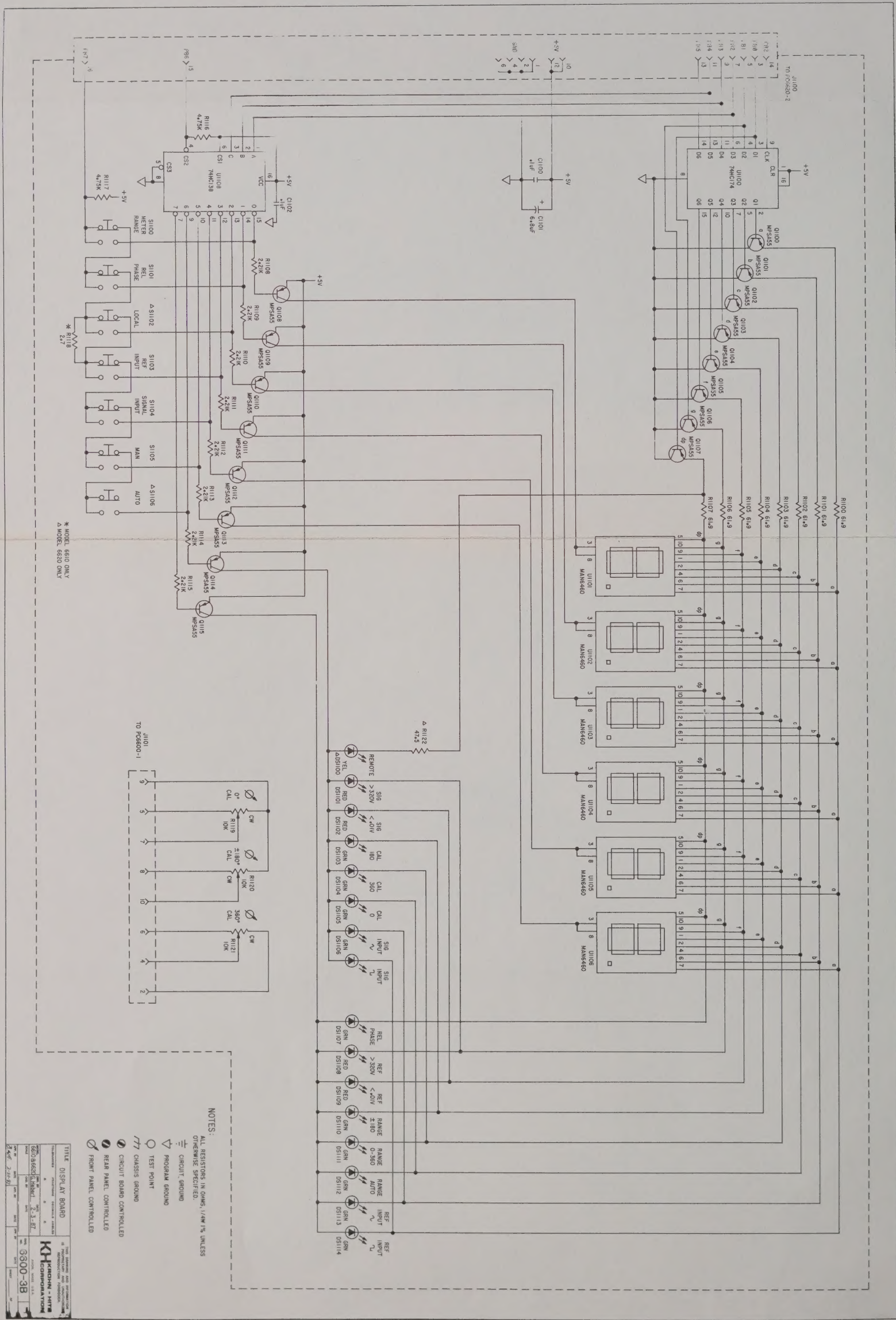




NOTES:  
ALL RESISTORS IN OHMS, 1/W 1% UNLESS OTHERWISE SPECIFIED  
CIRCUIT GROUND  
PROGRAM GROUND  
TEST POINT  
CHASSIS GROUND  
CIRCUIT BOARD CONTROLLED  
REAR PANEL CONTROLLED  
FRONT PANEL CONTROLLED



MODEL 6610





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